

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
20 February 2003 (20.02.2003)

PCT

(10) International Publication Number
WO 03/014220 A2

(51) International Patent Classification⁷: C08L 27/06,
C08J 9/32, C08K 7/22

(21) International Application Number: PCT/IT02/00519

(22) International Filing Date: 6 August 2002 (06.08.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
VR2001A000086 6 August 2001 (06.08.2001) IT

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,
SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ,
VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,
TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *without international search report and to be republished
upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: IMPROVED PROCESS FOR THE PRODUCTION OF A SYNTHETIC MATERIAL COMPRISING UNEXPANDED MICROSPHERES AS WELL AS LIGHT ARTICLES PRODUCED WITH SAID MATERIAL

(57) Abstract: A number of processes for the production of polyvinylchloride based material comprising expandable microspheres. Said material is advantageously used for the production of light articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their components, advantageously skirting-board, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic insulation, pipes, floaters, as well as for accident-prevention applications, sporting and sanitary applications, interior of motor-vehicles, handle grips, joysticks and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications, as also sole or the inner portions of shoes, being manufactured by a process of injection molding or intrusion molding or compression molding, as well as extrusion or calendaring.

**“ IMPROVED PROCESS FOR THE PRODUCTION OF A SYNTHETIC
MATERIAL COMPRISING UNEXPANDED MICROSPHERES AS WELL
AS LIGHT ARTICLES PRODUCED WITH SAID MATERIAL “**

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TECHNICAL FIELD

The present invention relates to new processes for the production of a synthetic material comprising unexpanded microspheres as well as new advantageous
10 formulations of such material obtained from a thermoplastic polymer, said material being advantageously used for the production of articles in new technical fields and said articles being provided with good physical and mechanical properties as well as a remarkable lightness.

Besides, the present invention relates to the use of the material as previously
15 defined, for the production of light articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their components, advantageously skirting-boards, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic insulation, pipes, floaters, as well as for accident-prevention applications, sporting and sanitary applications, interiors of
20 motor-vehicles, handle grips, joysticks and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications, as well as soles or inner portions of shoes, which are manufactured through a process of injection molding or intrusion molding or compression molding, as well as through extrusion or calendering.

25

BACKGROUND ART

The use of foamed polyvinylchloride (in the following PVC) for the production of many different articles obtained, for example, by means of a screw injection molding or by means of a transfer or intrusion device or by means of an

extrusion process is well known in the art.

The articles obtained from a material that is based on traditional foamed plasticized PVC are characterized by a density value which is generally higher than 0,7 g/cm³, this fact resulting in an article missing those characteristics of lightness which are needed in several categories of products..

A further drawback of the articles obtained with the traditional method with foamed PVC material is constituted by the fact that their external surface generally shows clearly evident streakings caused by the generation of consistent amounts of gaseous products produced by the decomposition of the foaming agent of the starting composition.

Said streakings give the finished product a poor aesthetical aspect that is absolutely unacceptable for particular kinds of products.

Furthermore gaseous products, which are uncontrollably generated inside the article during the production process, can develop bubbles also of remarkable dimensions.

Said gaseous bubbles are absolutely undesirable since they can cause swellings and, generally, a reduction of the mechanical properties of the article as well as the lowering of the quality thereof.

Owing to the above cited drawbacks caused by the use of a material which is based on foamed PVC, for several industrial sectors it is preferable to replace said PVC by other kinds of polymers, e.g. foamed double-component polyurethane.

In fact, although foamed double-component polyurethane is more expensive as well as more difficult to be molded and treated during the production process than foamed PVC, it is nevertheless preferred since it allows the production of very light articles greater surface quality.

International patent application n. WO99/14267 describes the production of a material obtained from a thermoplastic polymer such as a PVC resin and polymeric microspheres containing isopentane, said material being advantageously used for the production of articles that are provided with good physical and mechanical properties

as well as a remarkable lightness.

In the above document, a process for the production as well as the use of the material as previously defined for the manufacture of shoe components, advantageously soles, is further claimed.

5 Said document is limited to the description of a single process for the production of a material that is further used in the manufacture of plastic soles.

The process usually comprises three steps, a first mixing step usually performed in a turbomixer, a cooling step and an extrusion and/or granulation step.

10 According to the above mentioned document the microspheres are added only at the end of the mixing step or during the extrusion step. This determines several limitations to the process particularly in relation to the conditions of temperature and to its control at different steps.

15 Furthermore, the previously described material is usually produced starting from components that are advantageously mixed, extruded and granulated to form a granulated material ready for the following molding steps; however, the plants where the products are molded are often far away from the place of production of the granulated material, causing high costs for the transport and as a consequence a general increase of the cost of the final product.

20 On the other side, the production of the granulated material in a plant placed far away, and particularly by the same production plant of the final product, does not allow sensitive information to be kept sufficiently reserved, such as the technical know-how for the production of the granulated material, with the risk of its misappropriation.

25 Beyond the above mentioned problems, according to some forms of embodiment, the articles obtained by means of the granulated material described above are not enough resistant at low temperature, and as a consequence they can have cracks or breaks when left for a sufficiently long time to the action of said low temperature.

Finally, the material known in the art, as previously reported, has no rubbery

appearance at the touch, what limits its diffusion because this is a characteristic that is normally appreciated by the market.

DESCRIPTION OF THE INVENTION

5 The present invention aims to obviate to the disadvantages and drawbacks which are typical of the background art, and to provide, thus, processes to obtain a granular material based on a thermoplastic polymer suited to be further manufactured by a process of injection molding or intrusion molding or compression molding, as well as extrusion or calendering.

10 A first advantageous process related to the present invention, refers to the production of a material based on polyvinylchloride, said process comprising:

 in a first step, creating a a first mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, and a plasticizer, thereby to obtain a first mixture defined as "dry-blend" at a temperature
15 between 80°C and 130°C;

 in a second step, cooling said dry-blend down to a temperature close to 70°C and adding to the dry-blend a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, the second step being carried out under a strictly controlled thermal condition in order to substantially
20 avoid both breaking and expansion of said microspheres, and thereby to create a second mixture defined as "blended composition";

 in a third step, extruding and granulating the blended composition from the second step, whereby the thermal conditions and the extrusion rate of the extruder are kept under strict control in order to substantially avoid both breaking
25 and expansion of said microspheres, said third step resulting in a granulated material based on suspension polyvinylchloride material containing microspheres which are substantially integer and unexpanded.

 According to a further advantageous form of embodiment of the present invention, a process for the production of a material based on polyvinylchloride is

suggested, said process comprising:

in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, a plasticizer and a foaming agent other than expandible microspheres containing a volatile gas, thereby to obtain a mixture defined as "dry-blend" at a temperature
5 between 80°C and 130°C;

in a second step, cooling said dry-blend down to a temperature close to 70°C and adding to the dry-blend a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, the second step being
10 carried out under a strictly controlled thermal condition in order to substantially avoid both breaking and expansion of said microspheres, and thereby to create a blended composition;

in a third step, extruding and granulating the blended composition from the second step, whereby the thermal conditions and the extrusion rate of the extruder are kept under strict control in order to substantially avoid both breaking
15 and expansion of said microspheres, said third step resulting in a granulated material based on suspension polyvinylchloride material containing microspheres which are substantially integral and unexpanded.

A third advantageous form of embodiment according to the present invention
20 refers to a process for the production of a material based on polyvinylchloride, said process comprising:

in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature
25 between 80°C and 130°C;

in a second step, cooling said dry-blend down to a temperature close to 70°C and adding to the dry-blend a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent and a predetermined amount of a foaming agent other than polymeric microspheres containing a volatile gas, the

second step being carried out under a strictly controlled thermal condition in order to substantially avoid both breaking and expansion of said microspheres, and thereby to create a blended composition;

5 in a third step, extruding and granulating the blended composition from the second step, whereby the thermal conditions and the extrusion rate of the extruder are kept under strict control in order to substantially avoid both breaking and expansion of said microspheres, said third step resulting in a granulated material based on suspension polyvinylchloride material containing microspheres which are substantially integral and unexpanded.

10 A further advantageous form of embodiment according to the present invention refers to a process for the production of a material based on polyvinylchloride, said process comprising:

 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature
15 between 80°C and 130°C;

 in a second step, extruding and granulating the blended composition from the first step, said second step resulting in a granulated material based on suspension polyvinylchloride;

20 in a third step, adding to the granulated material a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said third step resulting in a mixed blend formed by a granulated material based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

25 According to a further advantageous form of embodiment of the present invention, a process for the production of a material based on polyvinylchloride is suggested, said process comprising:

 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a

plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

in a second step, extruding and granulating the blended composition from the first step, said second step resulting in a granulated material based on suspension polyvinylchloride;

in a third step, adding to the granulated material a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent and a wetting agent such as a plasticizer, said third step resulting in a mixed blend formed by a granulated material based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

Furthermore, a further aspect of the present invention refers to the production of a material based on polyvinylchloride, the process comprising:

in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

in a second step, performed at a substantially lower temperature, adding to the mixture a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said second step resulting in a mixed blend formed by a mixture based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

According to a further form of embodiment of the present invention, a process for the production of a material based on polyvinylchloride is suggested, said process comprising:

in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

in a second step, extruding and granulating the blended composition from the first step, said second step resulting in a granulated material based on suspension polyvinylchloride;

in a third step, adding to the granulated material a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent as dispersed in a solid or liquid carrier, said third step resulting in a mixed blend formed by a granulated material based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

10 A further not less valuable form of the present invention is a process providing the production of a material based on polyvinylchloride is suggested, said process comprising:

in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

in a second step, at a substantially lower temperature, adding to said dry-blend a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent as dispersed in a solid or liquid carrier, said second step resulting in a mixed blend formed by a mixture based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

Finally, according to a further form of the invention a process for the production of a material based on polyvinylchloride is suggested, said process comprising:

25 a single mixing step of the regenerated granules made of plasticized PVC, obtained from mechanical or chemical recycling, with an expanding agent made of expandable microspheres containing a volatile gas which are substantially integral and unexpanded,

said microspheres being added after wetting of the granules with a suited wetting agent such as for example DOP or added in the form of granules or paste in a concentrated form.

5 The claims depending from the previously claimed processes outline particularly advantageous forms of embodiment of same according to the invention.

The invention further refers to a material in the form of powder, as well as a granular or pellet-shaped material. Said material is described in claims 14 and 15.

Further mixtures to obtain said material are described in the claims from 16 to 21.

10 The claims from 22 to 25 that are dependent on claims 14 to 21 outline particularly advantageous forms of embodiment of said materials and mixtures according to the invention.

The claims from 27 to 29 refer to the use of the material according to the previous claims and to light articles being manufactured by processes of injection
15 molding or intrusion molding or compression molding, as well as extrusion or calendaring, for the production of light articles such as articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their accessories, advantageously skirting-boards, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic insulation, pipes, floaters, as
20 well as for accident-prevention applications, sporting and sanitary applications, interiors of motorvehicles, handle grips, joysticks and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications, as also sole or the inner portions of shoes.

According to an important feature of the present invention, the chemical
25 formulation of the material for the production of light articles comprises at least a thermoplastic polymer like for example a "compound" of expanded PVC but also regenerated granules of plasticized PVC obtained from a chemical or mechanical recycle, added of polymeric microspheres containing a foaming agent.

The process according to what is previously reported comprises mainly three

steps: a first mixing step usually carried out in a turbomixer, a cooling step and an extrusion and/or granulation step.

Further additives are added to the "compound" of expanded PVC to improve the physico-chemical and mechanical properties as well as the workability of said material.

Among said additives the followings may be mentioned, for instance: some thermal stabilizers, e.g. barium and zinc as well as calcium and zinc as well as barium and lead compounds; suitable costabilizers, e.g. epoxidate oil of soya; any other further additives to improve the molding of the material and to increase its lubrication, e.g. stearic acid.

Among the used additives one or more plasticizers are generally present.

In fact, said plasticizers act in such a way as to soften the composition, thereby providing for remarkable advantages during the production process as well as conferring specific properties to the final product and decreasing the viscosity during the transformation of the powder (dry-blend) in granule.

The presence of said plasticizers is important also for determining the hardness of the desired mix, said hardness varying according to the ratio between thermoplastic polymer and plasticizer.

Among the plasticizers the use of di-2-ethyl-esil-phthalate (DOP) is particularly preferred together with di-isononil-phtalate and di-isodecil-phtalate.

According to another form of embodiment of the present invention, a plasticizer commercially called "DOA", di-2-etil-esil-adipate, is comprised in the formulation of the material in the appropriate amount.

With the presence of DOA in the formulation, the material results rubbery to the touch, which is very important from a commercial point of view.

Furthermore, the low temperature resistance of the material substantially increases thanks to the presence of DOA, so that it can be bent several times at low temperatures without showing any cracking or splitting.

Other adipates such as di-isononil-adipate or linear phtalate can be also used

to obtain the low temperature resistance.

A further form of embodiment of the present invention comprises as an additive a further expanding agent cooperating with the action of the microspheres, which can be added both to the mixture comprising PVC at the beginning of the mixing process and afterward together with the microspheres.

The mixture composed of the basic thermoplastic material added of several additives is treated in the turbomixer according to the first step of the process. At this stage the temperature can be over 100 °C.

Thereafter the mixture is cooled off reaching a temperature around 70 °C and it is successively extruded/granulated.

As reported above, in addition to the thermoplastic polymer of the starting composition, the material according to the present invention comprises polymeric expandable microspheres containing a volatile gas advantageously but not exclusively isopentane.

Said microspheres act as foaming agent and are added in a suited amount to the thermoplastic polymer, according to the kind of thermoplastic polymer which is used and according to the article to be produced, i.e. according to the features as well as to the physical and mechanical properties to be provided to said article.

According to a particularly preferred form of embodiment of the invention, the polymeric coating that is used to obtain said microspheres is metha-acrylonitrile-polymethylmethacrylate, said microspheres being for instance marketed under the trade name EXPANCELL®.

According to the present invention, the addition of the microspheres alone or in a mixture with some additives can be planned at different steps of the process allowing different advantages according to the process line that is chosen.

In any case the whole process independently from the chosen line must avoid the break of said microspheres in the final material.

Considering that the expansion is directly connected to the values of temperature and pressure, these parameters are going to be specifically monitored

anytime the microspheres are added to the polymeric thermoplastic mixture.

According to a first process of the present invention the microspheres are added to the mixture at the end of the extrusion/granulation step of the polymeric thermoplastic mixture.

5 This results extremely favorable since all the process from the mixing to the extrusion step is independent from the presence of the microspheres and allows a grater flexibility for the parameters of temperature and pressure making the whole process more efficient and faster.

Furthermore, the manufacturing process of the thermoplastic material used as
10 starting material can be performed in suited plants while the microspheres can be added in plats dedicated to the molding and to the production of the final articles and products.

The addition to the extruded/granulated thermoplastic material according to the present invention can be both of microspheres as such and of microspheres together
15 with additives like wetting agents or dispersants that allow a better mixing or particular characteristics to the final articles.

As an example, according to the present invention, a plasticizer with a wetting effect added together with the microspheres is the di-2-etyl-esil-phthalate (DOP).

An advantageous application of the described process refers to the obtainment
20 of a particular mixture of the material comprising the microspheres.

The resulting product is a particular concentrated mixture defined as "master batch" that can be added at a further time, in the required amount, to the thermoplastic polymer to obtain the material for the extrusion.

In this way, the basic components of the mixture can be produced centered in a
25 production plant while the final granulated product can be obtained in another production plant wherein the thermoplastic polymer is treated.

This is very important to limit the costs of production and transport, particularly in the case where the used thermoplastic polymer is PVC that is easily found everywhere as dry-blend or granules.

The "master-batch" can be used both at the end of the extrusion/granulation step of the starting thermoplastic material and at the cooling step of the process without a further extrusion/granulation stage to obtain a final material ready for the molding, the extrusion or the calendering as well as ready to undergo all the steps of the process which has to be regulated in such a way to avoid the early expansion of the microspheres.

According to the process described for the "master-batch", the adding of the microspheres can be both of microspheres as such or associated with additives also at the end of the mixing step or during the cooling step without reaching the step of extrusion/granulation.

Thus, according to the processes described in the present invention, a material is obtained with formulations allowing density values to be reached, which are remarkable lower than those of similar materials belonging to the state of the art, said lower values being comprised in the range from 0,2 to 0,65 g/cm³, and more advantageously from 0,4 to 0,5 g/cm³; furthermore, also good physical and mechanical properties as well as high superficial esthetical results are achieved, all the above obtained with the highest flexibility for the industrialization process and the production according the related implemented variants.

Said material being used in processes of injection molding or intrusion molding or compression molding, as well as extrusion or calendering according to the present invention, allows light articles to be produced which are provided with good physical and mechanical properties as well as with high quality surface appearance since no disadvantageous and undesirable streakings or internal bubbles are present as it occurs in articles produced by means of other formulations known in the art as cited above.

DESCRIPTION OF SOME PREFERRED FORMS OF EMBODIMENT

According to the processes described in the present invention, polymeric microspheres containing a volatile gas are added to a mixture comprising a PVC

resin or, according to a particular form of embodiment, granules of regenerated plasticized PVC, obtained from mechanical or chemical recycling, added with components such as plasticizers, temperature stabilizers and lubricants which are used according to the desired final products.

5 According to the present invention, the addition of said microspheres is preferably performed at the most advantageous step of the process in view of the industrialization of the resulting material, considering the process as comprising a first mixing step, a cooling step and step of extrusion/granulation.

10 The microspheres can be added as such, in association with additives like for example wetting agents, desperdants and expanding agents according to the present invention, as well as in the form of "master-batch" i.e. a concentrated composition of said microspheres in a mixture of resin and related additives.

15 By keeping the parameters of pressure and temperature under control according to the implemented process, a final material can be obtained which includes the microspheres integer and unexpanded. The expansion will be performed only during the subsequent manufacturing process of the final products such as articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their accessories, advantageously skirting-boards, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic insulation, 20 pipes, floaters, as well as for accident-prevention applications, sporting and sanitary applications, interior of motor-vehicles, handle grips, hilts and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications.

25 In the following are shown two non-limiting examples of the starting compositions, which can be used in the process according to the invention to obtain the thermoplastic material based on PVC resin comprising microspheres containing a foaming agent.

EXAMPLE I

The following is a particular formulation of the material according to the present invention, advantageously for the production of plates used as panels for the building industry and for the furniture's industry or for the production of skirting

5 boards:

| | | |
|----|--|------|
| - | PVC suspension resin | 100 |
| - | Modifier for acrylic appearance | 5 |
| - | CPE (Chlorinated Polyethylene) | 2 |
| - | Calcium Carbonate | 8 |
| 10 | - Stabilizer | 5 |
| - | Polymeric microspheres containing isopentane | 2 |
| - | Azodicarbonamide | 0,25 |

wherein said amounts are indicated in parts per 100 parts of resin.

15

EXAMPLE II

The following is a further formulation of the material according to the present invention, particularly advantageous for tiles and bent tiles:

| | | |
|----|--|-----|
| - | PVC suspension resin | 100 |
| 20 | - Stabilizer | 6 |
| - | Process Adjuvant | 2 |
| - | Calcium Carbonate | 5 |
| - | Calcium Stearate | 0,5 |
| - | Polymeric microspheres containing isopentane | 2,5 |

25

Wherein said amounts are indicated in parts per 100 parts of resin.

In the following some examples of use are reported, in which a material

obtained by means of the process according to the present invention is advantageously applied:

Use 1

5 According to a particular form of embodiment of the present invention it is possible to produce co-extruded floorings where the side in contact with the feet is made of a compact plastic material of the traditional type with a thickness of around 2-3 mm, while the bottom side is realized with the material according to the present invention with a thickness of 10-15 mm.

10 This particular form of embodiment allows double-density kind of flooring to be obtained without having to add some other type of material in a further stage.

In fact, the use of the material related to the present invention allows a complete flooring to be obtained also with reference to the characteristics required by the above stepping side that can be for instance glazed, scratched, striped or provided of bumps.

15 Besides, the material produced according to the previous description and used in this particular application provides a good grip, which makes it nearly self-blocking. At the same time its particular softness determines a pleasant relaxing "pillow effect".

20 On the other hand, the currently traded double-density floorings are manufactured in three steps: the sheet that is in contact with the feet is extruded alone, then the expanded layer is manufactured by means of a spreading procedure and finally the two layers are joined together.

The advantage to obtain the final product by means of a single working step, according the present invention, is self-evident.

25 Another application in the field of the floorings is the production of tiles made of plastic material through injection molding.

According to this type of application a machine commonly known as "double-coloured" is used and performs first the molding of the part of the tile in contact with the feet made of a compact plastic material of the traditional type and then, by means

of a system changing the cover of the mold, the molding of a thicker layer with the synthetic material manufactured according to the invention.

Therefore, through this particular process, a double-density tile is obtained as a final product, by means of a single working step.

5 The synthetic material according to the present invention is completely auto-extinguishing and classifiable V-0 according to the Rule UL-94.

Use 2

10 According to a particular form of embodiment the material obtained according to the present invention is used for the realization of several kinds of pipes as for instance net reinforced pipes, normally used for the gardening or those reinforced with a spiral, comprising a spiral made of steel or plastic material with a function of support and reinforcement.

15 The great advantage in the use of the material according to the invention is first of all the lightness, besides the elevated flexibility accompanied by an excellent resistance at the low temperatures.

20 The pipe made of the material produced according to the present invention floats on water even if full, independently from the type of its reinforcement; also when it has great cross-sections it is easily shouldered from the operators and according to a particular form of embodiment it can be formulated to be impervious to the hydrocarbides and/or anti-static.

Use 3

25 A further use of the present invention refers to the realization of handgrips and knobs that result to be very light, wear resistant and with a favorable "rubbery" grip. More particularly, handgrips, for instance ski racket handgrips, that don't harden at low temperatures as well as wear resistant handgrips for job tools, are obtained.

Use 4

A further application field of the present invention is related to the realization of extruded profiles for the furniture industry particularly of tapestry (bumper molding), bumpers for child furniture etc.

5 The material obtained according to the present invention is worked very easily without the need of particular devices, neither for the injection of the gas for the polymeric matrix nor at the exit of the extruder, since the granule already comprises all what is needed to obtain the final material.

10 Since it is an foamed and rubbery product, it offers high resistance to the bumps and can be described as a "shock-absorber" material. Furthermore, thanks to its structure with closed cells it doesn't hold the liquids with which it comes in contact.

For the same reasons the present invention can also be applied to the production of gaskets obtained with an extrusion procedure.

15

Use 5

A further application of the invention, which derives from the low-density characteristics of the product obtained therefrom, refers to the production of floaters, like for example floaters for swimming pools.

20 In detail said application refers to small wheels, starlets and other forms of floaters, which are connected to a strained rope and usually employed for dividing the swimming pools into separate lines.

25 The great advantage represented by the use of this material, in comparison to the traditional ones, is the softness of the single components that avoids disagreeable bruises during the physical activity in a swimming pool.

The floaters obtained with the material according to the present invention normally resist very well to the extensive contact with seawater and chlorine added water as well as to other additives used in the treatment of the water in swimming pools.

Use 6

The material obtained according to the present invention is used to obtain protecting elements or their parts by means of injection molding, thereby assuring the
5 certainty about the dimensions of the element, a great saving of material and a low ecological impact (absence of scraps) compared to what is obtained with other materials of choice such as EVA and expanded PVC.

Currently several protecting elements are produced by assembling several parts cut off by plates, which could be replaced by few parts of the desired form.

10 The material obtained according to the present invention, thanks to its spongy structure, absorbs the bumps, though it does not absorb liquids and it dries off very quickly, it can be easily hot-welded or welded with ultrasounds, it is glued without problems and can be covered again with all the commonly used materials.

Its use is therefore advantageous for the production of shinbone protections,
15 vests, gloves, pillows, helmets, components to immobilize injured persons, etc..

Use 7

The material in all the different forms of embodiment obtained according to the invention, is realized with formulations which are free from heavy metals.
20 Furthermore, it can be formulated without the use of phtalate allowing the production of toys or their parts, always in consideration of the remarkable properties of lightness and softness.

A further advantage according to the present invention consists in manufacturing the material in the whole chromatic range, still maintaining the
25 maximum safety profile of the product.

Use 8

According to the present invention the material is used for manufacturing components for the auto industry and, particularly, for the inside furnishing of motor-

vehicles. In fact, extruded sheets for the production of dashboards and panels can be realized, which are advantageously soft, easily shaped and glued on a support, which don't produce the typical noises of the panels made of polypropylene, and they have a "rubbery" aspect, that is neither dry nor waxy and with a mat appearance.

5 Other components for the inside auto furnishing which are obtained according to a particular form of embodiment of the invention are fillings for the tapestry or shockproof pads.

Use 9

10 According to a particular form of embodiment, the product obtained according to the present invention is primarily formulated to be impervious to the aggressive action of the hydrocarbons (oils, gas-oil, gasoline, etc.) as well as with different degrees of anti-static properties. Accident-prevention footwear is produced, which is impervious to the fats and the oils and with anti-static properties able to prevent the
15 production of dangerous sparks.

 The product obtained according to the present invention is at the present the only alternative to the double-component polyurethane used for the production of the majority of accident-prevention footwear. Furthermore, said material involves several advantages: no trimming operations are required, it is completely recyclable
20 so that the possible scrapings derived from the working operations can be ground and immediately inserted again in the productive cycle and finally it can be worked with the normal devices for the molding of the PVC or the TPR that are much more convenient and easier to manage in comparison to the casting devices for the double-component polyurethane.

25

Use 10

 The product obtained according to the procedure described in the present invention is a foamed material with closed cells which comprises an high insulation capacity, being particularly suitable for the realization of sound- and thermal-

insulating panels and/or components.

According to a particular form of embodiment the panels are obtained through extrusion and a following calendering and when a remarkable thickness is desired they can be superimposed, or treated through press injection. Therefore, they can be rolls,
5 plates or tiles.

Another application, with reference to the aforesaid insulating properties, is the covering of plastic or metal pipes. According to a particular form of embodiment the product is directly extruded on the pipe to be insulated, thereby avoiding the later application of the insulating layer and allowing the permanent coating of the pipe.

10 A further interesting application for the material produced according to the invention is the use as filler in the insulating portion of cables. This allows the production of cables which are extremely light and, as a consequence, easy to handle.

The invention was previously described with reference to some preferred forms
15 of embodiment of the same.

However it is clear that the present invention is not limited to these particular forms of embodiment and is susceptible to several modifications and variations within the scope of the present invention, in the field of the technical equivalences.

CLAIMS

1. A process for manufacturing a material based on polyvinylchloride, said process comprising:

5 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, and a plasticizer, thereby to obtain a first mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

10 in a second step, cooling said dry-blend down to a temperature close to 70°C and adding to the dry-blend a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, the second step being carried out under a strictly controlled thermal condition in order to substantially avoid both breaking and expansion of said microspheres, and thereby to create a second mixture defined as "blended composition";

15 in a third step, extruding and granulating the blended composition from the second step, whereby the thermal conditions and the extrusion rate of the extruder are kept under strict control in order to substantially avoid both breaking and expansion of said microspheres, said third step resulting in a granulated material based on suspension polyvinylchloride material containing microspheres which are substantially integral and unexpanded.

20

2. A process for manufacturing a material based on polyvinylchloride, said process comprising:

25 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, a plasticizer and a foaming agent other than expandable microspheres containing a volatile gas, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

in a second step, cooling said dry-blend down to a temperature close to 70°C and adding to the dry-blend a predetermined amount of polymeric

microspheres containing a volatile gas as foaming agent, the second step being carried out under a strictly controlled thermal condition in order to substantially avoid both breaking and expansion of said microspheres, and thereby to create a blended composition;

5 in a third step, extruding and granulating the blended composition from the second step, whereby the thermal conditions and the extrusion rate of the extruder are kept under strict control in order to substantially avoid both breaking and expansion of said microspheres, said third step resulting in a granulated material based on suspension polyvinylchloride material containing microspheres which are
10 substantially integral and unexpanded.

3. A process for manufacturing a material based on polyvinylchloride, said process comprising:

 in a first step, creating a mixed blend of a suspension
15 polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

 in a second step, cooling said dry-blend down to a temperature close to 70°C and adding to the dry-blend a predetermined amount of polymeric
20 microspheres containing a volatile gas as foaming agent and a predetermined amount of a foaming agent other than polymeric microspheres containing a volatile gas, the second step being carried out under a strictly controlled thermal condition in order to substantially avoid both breaking and expansion of said microspheres, and thereby to create a blended composition;

25 in a third step, extruding and granulating the blended composition composition from the second step, whereby the thermal conditions and the extrusion rate of the extruder are kept under strict control in order to substantially avoid both breaking and expansion of said microspheres, said third step resulting in a granulated material based on suspension polyvinylchloride material containing microspheres

which are substantially integral and unexpanded.

4. A process for manufacturing a material based on polyvinylchloride, said process comprising:

5 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

10 in a second step, extruding and granulating the blended composition from the first step, said second step resulting in a granulated material based on suspension polyvinylchloride;

15 in a third step, adding to the granulated material a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said third step resulting in a mixed blend formed by a granulated material based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

5. A process for manufacturing a material based on polyvinylchloride, said process comprising:

20 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

25 in a second step, extruding and granulating the blended composition from the first step, said second step resulting in a granulated material based on suspension polyvinylchloride;

in a third step, adding to the granulated material a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent and a wetting agent such as a plastifier, said third step resulting in a mixed blend formed

by a granulated material based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

5 6. A process for manufacturing a material based on polyvinylchloride, said process comprising:

 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature
10 between 80°C and 130°C;

 in a second step, carried out at a substantially lower temperature, adding to the mixture a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said second step resulting in a mixed blend formed by a mixture based on suspension polyvinylchloride and by a foaming agent
15 constituted by microspheres containing a volatile gas which are substantially integer and unexpanded.

 7. A process for manufacturing a material based on polyvinylchloride, said process comprising:

 in a first step, creating a mixed blend of a suspension
20 polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

 in a second step, extruding and granulating the blended composition from the first step, said second step resulting in a granulated material based on
25 suspension polyvinylchloride;

 in a third step, adding to the granulated material a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent as dispersed in a solid or liquid carrier, said third step resulting in a mixed blend formed by a granulated material based on suspension polyvinylchloride and by a foaming

agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

8. A process for manufacturing a material based on polyvinylchloride, said process comprising:

5 in a first step, creating a mixed blend of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer and a plasticizer, thereby to obtain a mixture defined as "dry-blend" at a temperature between 80°C and 130°C;

10 in a second step, at a substantially lower temperature, adding to the dry-blend a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent as dispersed in a solid or liquid carrier, said second step resulting in a mixed blend formed by a mixture based on suspension polyvinylchloride and by a foaming agent constituted by microspheres containing a volatile gas which are substantially integral and unexpanded.

15

9. A process for manufacturing a material based on polyvinylchloride, said process comprising:

20 a single mixing step of the regenerated granules made of plasticized PVC, obtained from mechanical or chemical recycling, with an expanding agent made of expandable microspheres containing a volatile gas which are substantially integral and unexpanded, said microspheres being added after wetting of the granules with a suited wetting agent such as for example DOP or added in the form of granules or paste in a concentrated form.

25 10. A process according to anyone of the preceding claims, wherein said plasticizer is a benzoate and/or a short chain (C₄-C₇) phthalate and/or an adipate.

11. A process according to claim 10, wherein said plasticizer is di-2-ethyl-esil-phthalate (DOP), or di-isononil-phthalate or di-isodecyl-phthalate or di-2-ethyl-esil-

adipate.

12. A process according to anyone of the preceding claims, wherein said stabilizer is a compound based on calcium, zinc or other metals such as barium, cadmium, lead or tin.

13. A process according to anyone of claims 2 and 3, wherein said other foaming agent is azodicarbonamide (AZDC) or benzosulphonyl-hydrazide (OBSh) or a mixture of both.

14. A granular or pellet-shaped material based on polyvinylchloride wherein each granule or pellet is constituted by a first mixture defined as "dry blended composition" of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, and a plasticizer, as well as a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, whereby said microspheres which are substantially integer and unexpanded.

15. A granular or pellet-shaped material based on polyvinylchloride wherein each granule or pellet is constituted by a first mixture defined as "dry blended composition" of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, a plasticizer and a foaming agent other than microspheres containing a volatile gas, as well as a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, whereby said microspheres which are substantially integral and unexpanded.

16. A mixed blend comprising:
- a granular or pellet-shaped material based on polyvinylchloride characterised in that each granule or pellet is constituted by a first mixture, defined as "dry blended composition", of a suspension polyvinylchloride resin with at least one

of a thermal stabilizer, a co-stabilizer, a plasticizer; and

- a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said microspheres containing a volatile gas being substantially integral and unexpanded.

5

17. A mixed blend comprising:

- a granular or pellet-shaped material based on polyvinylchloride characterised in that each granule or pellet is constituted by a first mixture, defined as “dry blended composition”, of a suspension polyvinylchloride resin with at least one

10 of a thermal stabilizer, a co-stabilizer, a plasticizer;

- a wetting agent such as a plasticizer;
- a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said microspheres containing a volatile gas being substantially integral and unexpanded.

15

18. A mixed blend comprising:

- a material in form of a powder based on polyvinylchloride wherein said material in form of powder is constituted by a first mixture, defined as “dry blended composition”, of a suspension polyvinylchloride resin with at least one of a thermal

20 stabilizer, a co-stabilizer, and a plasticizer; and

- a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent, said microspheres containing a volatile gas being substantially integer and unexpanded.

25

19. A mixed blend comprising:

- a granular or pellet-shaped material based on polyvinylchloride characterized in that each granule or pellet is constituted by a first mixture, defined as “dry blended composition”, of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, a plasticizer; and

- a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent dispersed in a solid or liquid carrier, said microspheres containing a volatile gas being substantially integer and unexpanded.

5 20. A mixed blend comprising:

- a material in form of a powder based on polyvinylchloride wherein said material in form of powder is constituted by a dry blended composition of a suspension polyvinylchloride resin with at least one of a thermal stabilizer, a co-stabilizer, and a plasticizer;

10 - a predetermined amount of polymeric microspheres containing a volatile gas as foaming agent dispersed in a solid or liquid carrier, said microspheres containing a volatile gas being substantially integer and unexpanded.

21. A mixture comprising:

15 a material made of granules or pellets of regenerated plasticized PVC, obtained from mechanical or chemical recycling;

an expanding agent made of polymeric microspheres containing a volatile gas being substantially integer and unexpanded.

20 22. A material according to claim 14 or 15, characterised in that said plasticizer is di-2-ethyl-esil-phthalate (DOP) or di-isononil-phthalate or di-isodecil-phthalate or di-2-ethyl-esil-adipate.

23. A material according to claim 14 or 15, characterised in that said thermal
25 stabilizer is a compound based on calcium, zinc or other metals such as barium, cadmium, lead or tin.

24. A material according to claim 14, characterised in that said other foaming agent is azodicarbonamide (AZDC) or benzosulphonyl-hydrazide (OBSh) or a

mixture of both.

25. A mixed blend according to anyone of claims 16 to 21, characterised in that said plasticizer is di-2-etyl-esil-phthalate (DOP) or di-isononil-phthalate o di-isodecil-phthalate or di-2-etyl-esil-adipate.

26. A material according to claim 16 or 21, characterised in that said thermal stabilizer is a compound based on calcium, zinc or other metals such as barium, cadmium, lead or tin.

27. A light article made of a material based on suspension polyvinylchloride, in particular for the production of light articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their components, advantageously skirting-boards, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic isolation, pipes, floaters, as well as for accident-prevention applications, sporting and sanitary applications, interior of motor-vehicles, handle grips, joysticks and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications, said light article being manufactured by a process selected between injection molding, intrusion molding, compression molding, extrusion and calendering, wherein the material based on suspension polyvinylchloride used for carrying out said process is constituted by a granular or pellet-shaped material according to anyone of claims 14 and 15.

28. A light article made of a material based on suspension polyvinylchloride, in particular for the production of light articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their components, advantageously skirting-boards, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic isolation, pipes, floaters, as well as for accident-prevention applications, sporting and sanitary

applications, interior of motor-vehicles, handle grips, joysticks and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications, as also sole or inside portions of shoes, said light article being manufactured by a process selected between injection molding, intrusion molding, compression molding, extrusion and calendering, wherein in that the material based on polyvinylchloride used for carrying out said process is constituted by a granular or pellet-shaped material according to anyone of claims 16 and 21.

29. Use of the material obtained by means of a process according to anyone of the claims from 1 to 13 as manufactured by processes of injection molding or intrusion molding or compression molding, as well as extrusion or calendering, for the production of light articles such as articles for flooring, tiles and bent tiles, edges of pieces of furniture, furnishing elements and their components, advantageously skirting-boards, panels for the building industry and for furniture's industry, applications for the thermal and/or acoustic isolation, pipes, floaters, as well as for accident-prevention applications, sporting and sanitary applications, interior of motor-vehicles, handle grips, joysticks and toys, shock-proof elements, cables (as a filler), oil resistant and anti-static products or applications.